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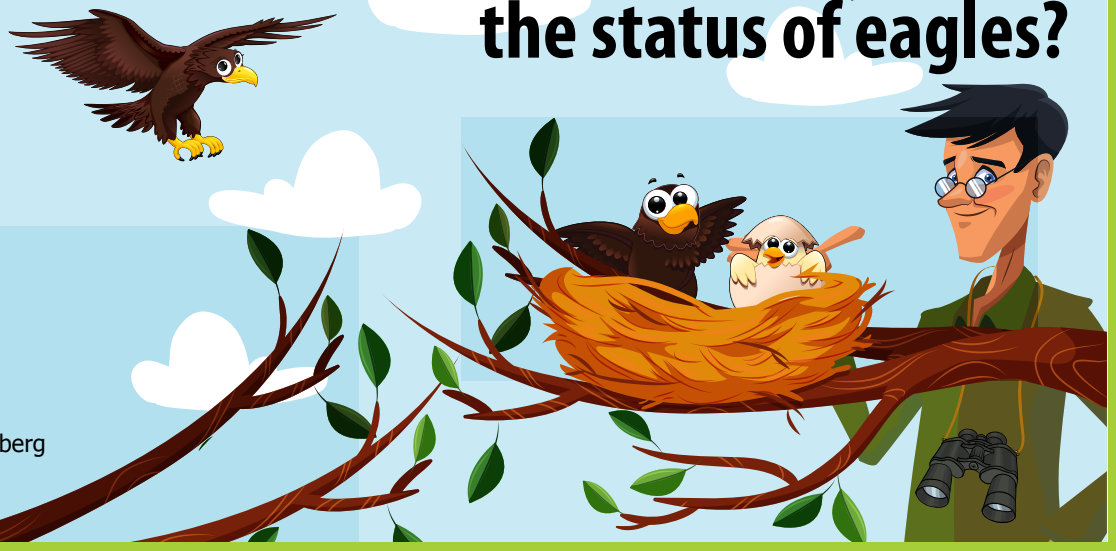
How can we quickly assess the status of eagles?



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Abstract

Can you predict how a movie will end by looking only at a couple of snapshots from some early scenes? That's what many ecologists have to do to quickly assess whether an animal population is at risk: they need a method to collect data quickly to predict how animal *populations* will fare in the future. This is especially difficult with animals that live long lives (like a really long movie!), such as whales, sea turtles, and birds of prey.

Here, we used a mathematical model to examine whether two commonly used snapshot *metrics* for assessing the health of long-lived eagle populations are reliable. And we are glad we did, because we found that they are not reliable. Commonly used measures like how many birds are able to breed and how young birds are when they begin to occupy nests do not accurately predict the status of an eagle population unless they are combined with other *data* such as the birds' survival rate or how much food and habitat is available to them.

Introduction

A golden eagle soaring high in the sky above us is a majestic sight (Fig. 1). However, some golden eagle populations in North America are declining and some in Europe and Asia are endangered. How can we tell whether an eagle population is likely to decline dangerously before it is too late?

To effectively protect wild animals, biologists need to assess how these animals are doing in any given area. For this purpose, they develop *rapid risk assessment* measures for various animal groups.

For long-lived, *territorial raptors* such as golden eagles, scientists commonly use two snapshot metrics (quick measurements) to figure out whether a population might be at risk:

Figure 1:
With a wingspan of up to 2.5 m (8 ft), the golden eagle is one of the biggest birds of prey in the world. These raptors can live more than 30 years in the wild. (Photo credit: alliswall.com)

- the *floater/breeder* ratio: it compares the number of adult birds that are looking for a nest/breeding territory ("floaters") to the number of birds that already occupy one and defend it from others ("breeders"). If there are more floaters than breeders, ecologists typically consider the population to be robust and healthy.
- the rate of *subadult* nesting: the proportion of nests occupied by immature ("teenage") birds that are not fully ready to breed yet. If subadults occupy a lot of nests, ecologists usually consider the population to be at risk because there may not be enough mature breeders and the population is likely shrinking.

We created a mathematical model that calculates these metrics under different conditions. This allows us to understand whether the snapshots accurately predict the status of a raptor population.

Methods

Our mathematical model was based on the following factors:

- the *life history* of golden eagles, which live one year as juveniles, three years as immature subadults ("teenagers"), and become adults when they reach their fifth year (see golden eagles' life history stages in Fig. 2)
- survival rates of the different eagle life stages
- reproductive rate: how many eggs female eagles laid, and how many of these eggs hatched
- how many birds were/weren't holding a territory at any given time
- availability of empty nesting territories
- how many male vs. female birds

To make our model realistic, we included data obtained from a 7-year study of golden eagles in California for some of these factors. We then ran our model and simulated 12 scenarios for an eagle population over 50 years. They were based on different survival rates, reproductive rates, trends in habitat loss or habitat gain, and the number of available territories. This allowed us to see if the two snapshot metrics predicted the future of the population correctly under all these different circumstances.

Figure 2:
Life history stages of golden eagles

Picture credits:
By Tony Hisgett from Birmingham, UK (Golden Eagle 3a)
Tom Koerner/USFWS
By Bureau of Land Management Oregon and Washington (An Eagle near Lakeview, Oregon)
Bradley Hacker /Macaulay Library at the Cornell Lab of Ornithology

Results

Our calculations showed that the two snapshot metrics alone were not reliable for predicting the status of golden eagle populations under most circumstances.

For instance, biologists usually interpret a high floater/breeder ratio (i.e. more floaters than breeders) as a sign that an eagle population is stable, because there are enough adult birds waiting to occupy a territory and start breeding once one becomes available. However, if the habitat is getting smaller, the floater/breeder ratio can stay high even when the population is declining. This occurs simply because the number of territories is being reduced and breeders are forced to become floaters (Fig. 3 top).

Please see Figure 3 on Page 3

The snapshots can also be misleading if many territories are empty. This could happen if the population is recovering after some previous decline. In this case, any eagle that wants a territory can get one so there are no floaters (floater/breeder ratio is 0). Biologists would usually interpret this snapshot as a sign that the eagle population is in trouble, while actually the population could be growing quite well (Fig. 3 bottom)

What happens to the overall population when eagles lose their habitat ? What happens to the floater/breeder ratio? And would the traditional understanding of this snapshot metric (the higher the floater/breeder ratio, the more stable the population) have predicted the true trend of the overall population?

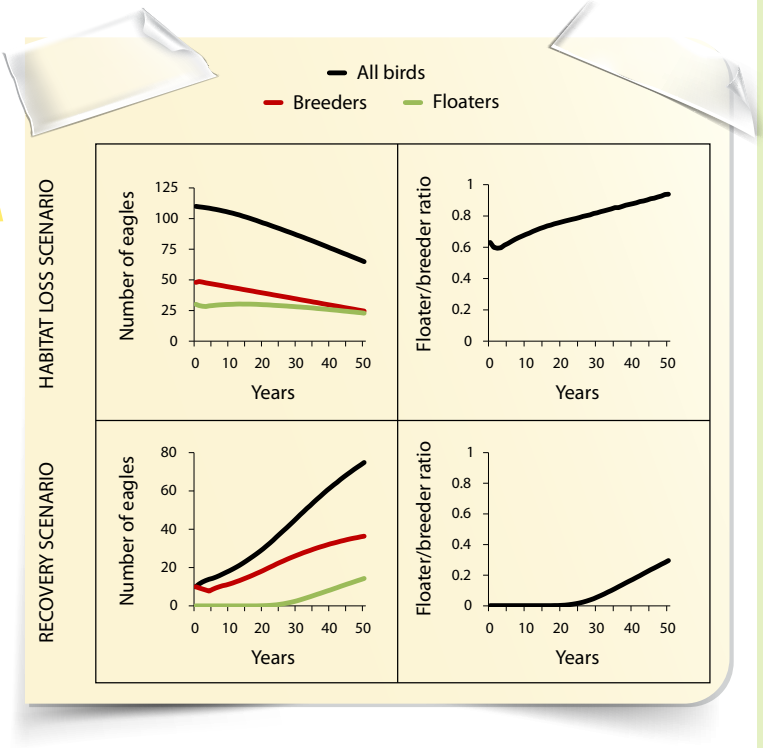

Figure 3:
Number of golden eagles in our simulated populations (left graphs) and floater/breeder ratio (right graphs) during a 50-year period when habitat is decreasing (top graphs) or the eagle population is recovering (bottom graphs).

Discussion

Our simulations showed that both snapshot metrics biologists commonly use for predicting the future of eagle populations are not very reliable when used alone. Instead, context is key: these metrics work best when there is a medium level of risk for the eagle population, but they do a poor job when risk level is high or low.

We found that another metric - the rate of survival of adult birds - was more important for assessing whether an eagle population was at risk or not. It also increased the value of the other two snapshot metrics when all three were used together.

To illustrate this, think through the following scenario: When adult survival is high, a low floater/breeder ratio only means that there is a low risk for the eagle population. However, when adults die at a higher rate (low adult survival), a low floater/breeder ratio means that there is a much higher risk for the entire eagle population. So in order to not sound a false alarm or provide a false sense of security, we suggest that biologists include (at least) an estimate of adult survival rate in their assessments.

Conclusion

It is hard to look at long-lived creatures like golden eagles and quickly assess how well they are doing, but that is what wildlife biologists and conservation specialists have to do. Therefore, it is crucial to find snapshot metrics that provide the most reliable prediction.

What is your favorite animal? Imagine you were tasked with determining whether its population is declining, stable, or growing, but you only have one year to make your assessment. What metrics do you think would give you a reliable prediction and how would you collect the data?

Glossary of Key Terms

Breeder – adult (mature) birds that occupy a nest and defend a territory around the nest.

Data – facts that can be analyzed or used in an effort to gain knowledge or make decisions.

Floater – adult birds that are looking for a nest and breeding territory.

Life history – the series of changes an organism goes through during its lifetime. Usually, there are defined stages in the life of an animal, like juvenile, subadult, adult, etc.

Metric – a measure of a certain characteristic of a population. In this study, we looked at the floater/breeder ratio, the rate of subadults occupying nests, and the adult survival rate.

Population – a group of animals from the same species that live in a certain area.

Rapid risk assessment – a quick way to tell whether something (in our case, a golden eagle population) is at risk. Usually, biologists use so-called snapshot metrics to quickly assess the status of (or risk to) a population of animals.

Raptor – a bird with powerful beak and talons that hunts and feeds on other types of animals. Also called "birds of prey," raptors include eagles, hawks, and owls.

Subadult – adolescent birds (akin "teenagers"). Immature golden eagles that are 2-4 years old and are not ready to breed yet, but may take over an available nesting territory.

Territorial – defending an area of habitat (a territory) against intruders.

Check your understanding

1. What is a snapshot metric?
2. Why do we need snapshot metrics?
3. What is the problem with the two current snapshot metrics used for rapid risk assessment of raptor populations?
4. How can we overcome that problem?
5. What if scientists wanted to assess how well a particular human population is doing? What kind of metrics do you think they would have to look at?

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